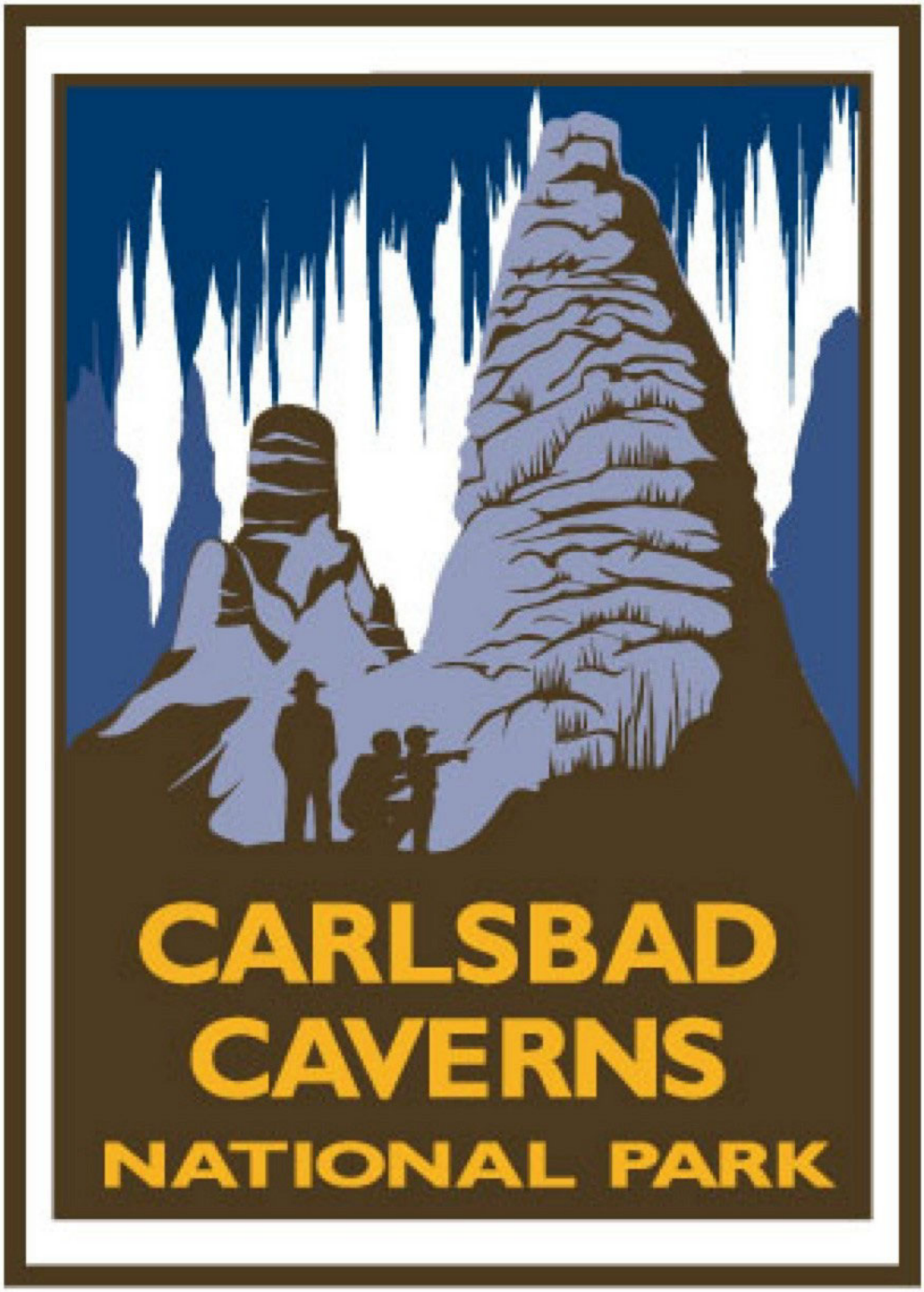
# Life Science

**A curriculum and activity guide for Carlsbad Caverns National Park**

## *Middle School Ecology*



# Soil

Desert soils have some very unique characteristics. Desert soils are usually mineral rich. However, they have less organic materials (decaying plant and animal material) than other soils. This organic material produces nitrogen that is important for plant growth and helps the soil hold water. Windblown and rain-dissolved particles create a dark sheen called “desert varnish.” Some minerals in the desert soil cement the soil together forming what is known as “hardpans,” commonly known as caliche, a hard crust that makes the soil less permeable to rainwater. In some parts of the desert tiny plants and small plantlike organisms such as lichens create a fragile living crust on the desert soil. This living crust can be found in Carlsbad Caverns National Park.

This unit will focus on the basics of soil science through two hands-on activities. In the first activity, *Let’s Get Down and Dirty,* students will participate in a hands-on experiment to identify different soil types and their water holding ability. In the second activity, *Succession and Compaction,* students will examine the influence of soil compaction on plants, animals, and on the water infiltration rate.

# Let's Get Down and Dirty!

***What is in our soil and how much water does it hold?***

**Summary:** This lesson is designed to help students understand the characteristics of different soils and their water-holding ability.
**Duration:** 1 class period
**Setting:** Classroom
**Vocabulary:** soil, stony soil, sandy soil, clay soil, loam, peat soil, desert varnish, hardpans
**Standards/Benchmarks Addressed:** SC1-E1, SC1-E2, SC2-E1, SC2-E2, SC2-E3, SC3-E1, SC4-E1, SC4-E3, SC4-E4, SC4-E5, SC5-E1, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC6-E7, SC12-E2, SC14-E2, SC16-E3

**Objectives**
Students will:

- investigate soil samples and determine the basic components of those soils.
- determine how much of a soil is rock.
- test the water-holding ability of different soil samples.

**Background**
Soil is the part of the ground where plants grow. Soil is a mixture of tiny particles of rock and rotting plant and animal material, with water and air between them. Soils help plants grow in two ways. First, soil holds the plants into place. Second, soil contains nutrients that plants need in order to survive. These nutrients include water, a nutrient needed by all living things. Water is absorbed into the soil and can be used by plants and other living organisms to stay healthy and survive.

There are many different types of soil. Each type of soil absorbs water at a different rate. The main types of soil focused on in this lesson are stony soil (soil that contains mostly rocks), sandy soil (soil that contains mostly sand), clay soil (soil that contains fine particles, and is heavy, cool, and damp), loam (soil that contains sand and clay), and peat soil (soil that contains decayed plants).

Desert soils have some very unique characteristics. Desert soils are usually mineral rich. However, they have less organic materials (decaying plant and animal material) than other soils. This organic material produces nitrogen that is important for plant growth and helps the soil hold water. Windblown and rain-dissolved particles create a dark sheen called "desert varnish." Some minerals in the desert soil cement the soil together forming what is known as "hardpans," commonly known as caliche, a hard crust that makes the soil less permeable to rainwater. In some parts of the desert tiny plants and small plantlike organisms such as lichens create a fragile living crust on the desert soil. This living crust can be found in Carlsbad Caverns National Park.

Biologists at Carlsbad Caverns National Park must be aware of the soil types and water infiltration rates of these soils in order to conserve the plant life in the park for future generations.

**Materials**
Soil samples (stony soil, sandy soil, clay soil, loam, peat soil)
Styrofoam cups (all the same size)
Glass jars (the cups should fit into the mouth of the jars)
Measuring cups
Bowl
Fine mesh screen
Paper towel
Magnifying glass

**Procedure**
***Warm up:*** Ask the students, "When you think of soil what comes to mind?" List the students' responses. Discuss what soil is.

**Activity**
1. Have five stations around the room set up for students to observe the five soil samples (stony soil, sandy soil, clay soil, loam, peat soil). Have the students use the small mesh screen to filter out the different size particles, and use a magnifying glass to observe the characteristics of each type of soil. Have the students write their observations in a science journal. After all students have had a chance to observe the five soil samples discuss their observations as a class. Have them try to identify what each soil sample is.
2. Ask the students, "Do all soils store the same amount of water?" Use the same five soils and have the students test the water-holding ability of each soil. Have students follow these directions:
    a. Each student should have 5 Styrofoam cups and 5 jars. The students should punch a small hole in the bottom of each of the Styrofoam cups.
    b. Line each cup with a circle of paper towel. Fill each cup ½ full of soil. Put only one soil type in each cup. Have students label each cup with the soil type and record it on the data sheet.
    c. Place each Styrofoam cup into the mouth of a jar. Pour an equal amount of water (1 to 2 cups) over the soil in each can.
    d. When each cup stops dripping have students measure the amount of water in the jar. To do this they must pour the water out of the jar into a measuring cup. Record the amount of water in each jar on the data sheet next to the corresponding soil sample.
    e. Have students write up the results of the water-holding ability of each type of soil. Have them explain which soil they feel would be best for planting crops.

***Wrap Up:*** Have the students answer the following questions:
1. Does the water drain more rapidly through some soils than others? Why do you think this happens?
2. When the water stopped dripping from the cups were the jars equally full? If not, which soils retained the most water? Which soils held the least amount of water?
3. Which soil do you think would be best for planting crops? Why?

**Assessment**
Write-up of soil characteristics, Lab write-up (water-holding ability), and answers to wrap up questions.

## Extensions

***Salt Flats:*** Salt flats and pans can be found in most deserts. They were formed when large bodies of water repeatedly evaporated and left behind a residue of salt. In some saltpans there is still water present. In other places the ground is completely covered with a crust of salt.

1. To show your class how a salt flat is formed, stir 5 tablespoons of table salt into 2 cups of warm water. Pour the solution into a glass loaf pan. Make a paper ruler and tape it to the side of the pan so kids can easily read the depth of the water. Place the pan on a sunny windowsill. Have the students check the pan every day and use a highlighter to mark the water level. Continue to do this until all the water evaporates. Then pass the pan around and ask: Where did the water go? What is the residue?
2. Make a salt lake by filling a pie pan with an inch or two of sand and covering it with the water solution (same mixture as above). Set it in a sunny windowsill. Have the students observe what happens as it evaporates. Ask: What did the water leave behind? How does this compare to what real salt flats and pans look like? (Discuss the salt flats around Carlsbad, New Mexico; bring in pictures to show students.)
3. Students will set up an experiment using different kinds of soils—sandy, stony, clay, loam, and peat—and compare their findings with the original exercise.

# Soil Observation Lab

**Name _____**

Use the small mesh screen to filter out the different size particles in each soil type. Use the magnifying glass to observe the five soil types. Note the characteristics (particle sizes, consistency, texture, living matter, and non-living matter) of each type in the correct column on the following chart.

| Soil Type | Characteristics |
|---|---|
| Stony soil | |
| Sandy soil | |
| Clay soil | |
| Loam | |
| Peat soil | |

***Water-Holding Ability Lab:*** Using the five soil samples—stony soil, sandy soil, clay soil, loam, and peat soil—test the water-holding ability of each soil.

**Lab Directions:**

a. You will need 5 Styrofoam cups and 5 jars. Punch a small hole in the bottom of each of the Styrofoam cups.

b. Line each cup with a circle of paper towel. Fill each cup ½ full of soil. There should be one soil in each cup. Label each cup with the soil type.

c. Place each Styrofoam cup into the mouth of the jar. Pour an equal amount of water (1 to 2 cups) over the soil in each cup.

d. When each cup stops dripping measure the amount of water in the jar. To do this pour the water out of the jar into a measuring cup. Record the amount of water in each jar on the data sheet next to the corresponding soil sample.

| Soil Type | Amount of water put into the soil | Amount of water filtered out of the soil | Amount of water held by the soil |
|---|---|---|---|
| Stony soil | | | |
| Sandy soil | | | |
| Clay soil | | | |
| Loam | | | |
| Peat soil | | | |

Based on the information obtained through this investigation, which soil type do you feel would be best for planting crops? Why?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

# Succession and Soil Compaction

***Does soil compaction affect plant and animal life?***

**Summary:** Students will compare two study sites to see if soil compaction affects the plant and animal life.
**Duration:** 1 class period
**Setting:** Outdoors
**Vocabulary:** succession, soil compaction, water infiltration rate
**Standards/Benchmarks Addressed**: SC1-E1, SC1-E2, SC2-E1, SC2-E2, SC3-E1, SC4-E1, SC4-E2, SC4-E4, SC4-E5, SC5-E1, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC6-E7, SC11-E4, SC11-E6, SC12-E2, SC14-E3, SC16-E1, SC16-E2, SC16-E3

**Objective**
Students will examine the influence of soil compaction on plant and animal habitats and on the water infiltration rate.

**Background**
Going into the desert should be a treasured experience. As you travel in the pristine wilderness, such as the Chihuahuan Desert of Carlsbad Caverns and Guadalupe Mountains National Parks, be sure to leave no trace. A very valuable lesson that needs to be learned is the effects of human impact on the soils of this delicate area. When hiking in the desert, stay on an established trail. There are cryptogamic soils (living soils such as lichens) that are easily destroyed. Walking off the trail also leads to unnecessary erosion and can harm the fragile plant life that grows near the trail.

Although soil type is the most important factor in determining the water infiltration rate of soil, another important factor is compaction. Highly compacted soils and high traffic areas are often less permeable and this leads to the destruction of plant and animal life.

Soil structure is important because it determines the ability of soil to hold and conduct water, nutrients, and air necessary for plant root activity. Some research has been conducted on soil compaction and its effects on plant growth. Soil compaction occurs when soil particles are pressed together, reducing pore space between them. Heavily compacted soils contain few large pores and have a reduced rate of both water infiltration and drainage from the compacted layer. This occurs because large pores are the most effective in moving water through the soil when it is saturated.

Soil compaction can have both desirable and undesirable effects on plant growth. Slightly compacted soil can speed up the rate of seed germination because it promotes good contact between the seed and soil. In addition, moderate compaction may reduce water loss from the soil due to evaporation and, therefore, prevent the soil around the growing seed from drying out. Excessive soil compaction impedes root growth and therefore limits the amount of soil explored by roots. This, in turn, can decrease the plant's ability to take up nutrients and water.

There are several causes of soil compaction, both natural and man-induced. Raindrop impact is a natural cause of compaction. We see it as soil crust that may prevent seedling emergence. Wheel traffic is a major cause of soil compaction. Excessive driving on delicate soils with four-wheel-drive vehicles usually causes wheel traffic compaction.

The effect of compaction on plant growth depends on the crop grown and the environmental conditions that crop encounters. In general, under dry conditions some compaction is beneficial, but under wet conditions compaction decreases yields.

**Materials**
Ice pick
Tin cans
Water
Paper
Pencils

**Procedure**
***Warm up:*** Ask students if they think hard packed soil affects the plants and animals that live there. Do they think the hardness of the soil affects the water infiltration rate? Discuss the students' answers. Explain that they are going to do a project to see the effects of soil compaction on water infiltration, plants, and animals.

***Activity***

1. Have the students select two sites on the school campus. One site should be a high traffic site where students often congregate. The other site should be a site where there is little or no student traffic.
2. Students will work in small groups to observe and classify the natural cover and litter (living and dead plants, insects, human impact) of each site. Have the students sketch their findings in a journal.
3. Students will measure the soil's compaction at each site by recording the average depth to which an ice pick penetrates the soil when dropped several times from a height of 3-4 feet. Students should record their average depths in their journals.
4. Students will measure the water infiltration rate of each site. This can be done by placing a tin can with both ends cut out, into the soil, filling it with a known quantity of water (the water amounts must be exactly the same), and recording the length of time necessary for all of the water to penetrate into the soil.
5. Students will compare the data obtained from the two sites and discuss the effects and relationships of soil compaction and living organisms.

***Wrap Up*:** Students write a paragraph on the following question: "Do you feel that soil compaction has an effect on the water infiltration rate and plant and animal life?"

**Assessment**
Collect journals and sketches